

ACCOMMODATING INTRAOCULAR LENS HAVING T-SHAPED HAPTICS

RELATED APPLICATIONS

This application is a continuation-in-part of my application Ser. No. 08/388,735, filed Feb. 15, 1995, now abandoned.

Reference is made to my copending application Ser. No. 08/640,118, which is a continuation, with intermediate continuation applications of my U.S. Pat. No. 5,476,514. Reference is also made to my U.S. Pat. No. 5,496,366.

BACKGROUND OF THE INVENTION

This invention relates generally to intraocular lenses to be implanted within a natural capsular bag in the human eye formed by evacuation of the crystalline matrix from the natural lens of the eye through a anterior capsulotomy in the lens. The invention relates more particularly to novel accommodating intraocular lenses of this kind having a number of improved features including, most importantly, increased amplitude or diopters of accommodation.

The human eye has an anterior chamber between the cornea and iris, a posterior chamber behind the iris containing a crystalline lens, a vitreous chamber behind the lens containing vitreous humor, and a retina at the rear of the vitreous chamber. The crystalline lens of a normal human eye has a lens capsule attached about its periphery to the ciliary muscle of the eye by zonules and containing a crystalline lens matrix. This lens capsule has elastic optically clear anterior and posterior membrane-like walls commonly referred to by ophthalmologists as anterior and posterior capsules, respectively. Between the iris and the ciliary muscle is an annular crevice-like space called the ciliary sulcus.

The human eye possesses natural accommodation capability. Natural accommodation capability involves relaxation and contraction of the ciliary muscle of the eye by the brain to provide the eye with near and distant vision. This ciliary muscle action is automatic and shapes the natural crystalline lens to the appropriate optical configuration for focusing on-the retina the light rays entering the eye from the scene being viewed.

The human eye is subject to a variety of disorders which degrade or totally destroy the ability of the eye to function properly. One of the more common of these disorders involves progressive clouding of the natural crystalline lens matrix resulting in the formation of what is referred to as a cataract. It is now common practice to cure a cataract by surgically removing the cataractous human crystalline lens and implanting an artificial intraocular lens in the eye to replace the natural lens. The prior art is replete with a vast assortment of intraocular lenses for this purpose.

Intraocular lenses differ widely in their physical appearance and arrangement. This invention is concerned with intraocular lenses of the kind having a central optical region or optic and haptics which extend outward from the optic and engage the interior of the eye in such a way as to support the optic on the axis of the eye.

Up until the late 1980s, cataracts were surgically removed by either intracapsular extraction involving removal of the entire human lens including both its outer lens capsule and its inner crystalline lens matrix, or by extracapsular extraction involving removal of the anterior capsule of the lens and the inner crystalline lens matrix but leaving intact the posterior capsule of the lens. Such intracapsular and extra-

capsular procedures are prone to certain post-operative complications which introduce undesirable risks into their utilization. Among the most serious of these complications are opacification of the posterior capsule following extracapsular lens extraction, intraocular lens decentration, cystoid macular edema, retinal detachment, and astigmatism.

An improved surgical procedure called anterior capsulotomy was developed to alleviate the above and other post-operative complications and risks involved in intracapsular and extracapsular cataract extraction. Simply stated, anterior capsulotomy involves forming an opening in the anterior capsule of the natural lens, leaving intact within the eye a capsular bag having an elastic posterior capsule, an anterior capsular remnant or rim about the anterior capsule opening, and an annular crevice, referred to herein as a cul-de-sac, between the anterior capsule remnant and the outer circumference of the posterior capsule. This capsular bag remains attached about its periphery to the surrounding ciliary muscle of the eye by the zonules of the eye. The cataractous natural lens matrix is extracted from the capsular bag through the anterior capsule opening by phacoemulsification and aspiration or in some other way after which an intraocular lens is implanted within the bag through the opening.

A relatively recent and improved form of anterior capsulotomy known as capsulorhexis is essentially a continuous tear circular or round capsulotomy. A capsulorhexis is performed by tearing the anterior capsule of the natural lens capsule along a generally circular tear line substantially coaxial with the lens axis and removing the generally circular portion of the anterior capsule surrounded by the tear line. A continuous tear circular capsulotomy or capsulorhexis, if performed properly provides a generally circular opening through the anterior capsule of the natural lens capsule substantially coaxial with the axis of the eye and surrounded circumferentially by a continuous annular remnant or rim of the anterior capsule having a relatively smooth and continuous inner edge bounding the opening. When performing a continuous tear circular capsulorhexis, however, the anterior rim may sometimes be accidentally torn, nicked, or otherwise ruptured, which renders the rim prone to tearing when the rim is stressed, as it is during fibrosis as discussed below.

Another anterior capsulotomy procedure, referred to as an envelope capsulotomy, involves cutting a horizontal incision in the anterior capsule of the natural lens capsule, then cutting two vertical incisions in the anterior capsule intersecting and rising from the horizontal incision, and finally tearing the anterior capsule along a tear line having an upper upwardly arching portion which starts at the upper extremity of the vertical incision and continues in a downward vertical portion parallel to the vertical incision which extends downwardly and then across the second vertical incision. This procedure produces a generally archway-shaped anterior capsule opening centered on the axis of the eye. The opening is bounded at its bottom by the horizontal incision, at one vertical side by the vertical incision, at its opposite vertical side by the second vertical incision of the anterior capsule, and at its upper side by the upper arching portion of the capsule tear. The vertical incision and the adjacent end of the horizontal incision form a flexible flap at one side of the opening. The vertical tear edge and the adjacent end of the horizontal incision form a second flap at the opposite side of the opening.

A third capsulotomy procedure, referred to as a beer can or can opener capsulotomy, involves piercing the anterior capsule of the natural lens at a multiplicity of positions along a circular line substantially coaxial with the axis of the eye